Riding the Waves of Biodiversity:

How Ocean Surfing Influences Our Body Microbiome

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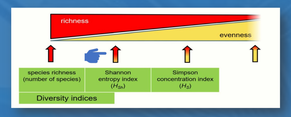
INTRODUCTION

The microbiome, a collection of microorganisms present in an environment, plays a vital role in maintaining the health and well-being of both humans and the environment. In the field of microbiology, a common assumption is that a higher level of biodiversity, or the presence of a larger number of distinct bacterial taxa, indicates a more desirable or beneficial state of health.

This study investigates which part of the human body habitat has the highest microbial diversity within the surfing population.

The Shannon index diversity will be used in this study which takes into account both the richness and the evenness of the microbial community, whereas the number of species metric mainly focuses on the richness.

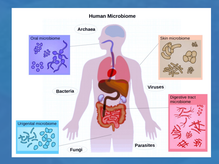


BACKGROUND

Microbes (bacteria, fungi, and viruses) constitute approximately 98% of the ocean's biomass and are essential for the marine ecosystem's health[1]. These microscopic organisms, which are smaller than dust mite excreta and have a diameter of less than five microns, are abundant in every liter of seawater and comprise cellular life forms such as phytoplankton (algae) and bacteria[1].

Millions of these tiny animals, which are smaller than dust mite excreta and less than five microns in size, live in every liter of seawater and include cellular life forms such as phytoplankton (algae) and bacteria[1]. Water microbes are arguably the most crucial animals for the planet's health and sustainability.

Surfers are exposed to the outdoor environment (and the ocean) more than the average person. Therefore, the bacterial composition on (and in) their bodies may reflect both their health and the health of the oceans where they surf.



HYPOTHESIS

Atlantic Ocean surfers have a higher Shannon index of microbial diversity in their bodies than Pacific Ocean surfers.

DATASET / METHOD

- The publicly available data was obtained from QIITA and the Surfer Biome Project (QIITA ID 11404).
- The dataset contains 296 columns and 504 rows.
- The R programming language was used to perform statistical analysis (mean, Interquartile Range IQR, standard deviation, Analysis of Variance ANOVA, Tukey's honestly significant difference HSD test) and create graph visualizations.

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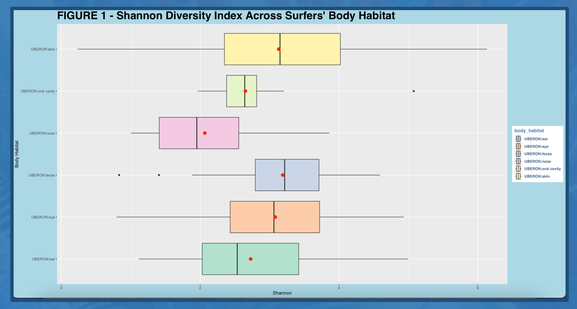
RESULTS / FINDINGS

Shannon Diversity Index

By Body Habitat

FIGURE 1 - Shannon Diversity Index Across Surfers' Body Habitat



Body Habitat	Number of Sample	Lower	Mean	Upper	Difference	Standard Deviation
UBERON:skin	234	0.23	3.13	6.13	5.90	1.24
UBERON:oral cavity	47	1.97	2.65	5.08	3.11	0.46
UBERON:nose	47	1.00	2.07	3.86	2.86	0.77
UBERON:feces	83	0.83	3.19	4.59	3.76	0.76
UBERON:eye	49	0.79	3.08	4.93	4.14	0.99
UBERON:ear	44	1.12	2.73	5.00	3.88	1.00
	504					

By Ocean ~ Body Habitat

FIGURE 2 - Shannon Index Diversity Discovered in Surfers' Body Habitat

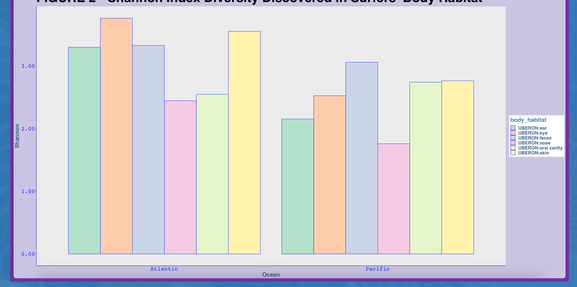
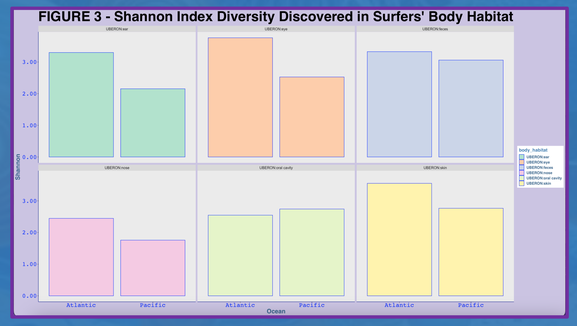


FIGURE 3 - Shannon Index Diversity Discovered in Surfers' Body Habitat



Ocean	Body_Habitat	Number of Sample	Lower	Mean	Upper	Difference	Standard_Deviation
Atlantic	UBERON:ear	22	1.22	3.30	5.00	3.78	0.98
Atlantic	UBERON:eye	22	2.33	3.76	4.93	2.60	0.74
Atlantic	UBERON:feces	40	1.88	3.33	4.59	2.70	0.82
Atlantic	UBERON:nose	21	1.37	2.45	3.86	2.49	0.80
Atlantic	UBERON:oral cavity	22	2.09	2.55	2.93	0.84	0.25
Atlantic	UBERON:skin	109	0.23	3.55	6.13	5.90	1.22
Pacific	UBERON:ear	22	1.12	2.15	3.25	2.13	0.62
Pacific	UBERON:eye	27	0.79	2.53	3.98	3.18	0.80
Pacific	UBERON:feces	43	0.83	3.06	4.49	3.66	0.68
Pacific	UBERON:nose	26	1.00	1.76	3.24	2.24	0.60
Pacific	UBERON:oral cavity	25	1.97	2.74	5.08	3.11	0.57
Pacific	UBERON:skin	125	0.38	2.77	5.20	4.82	1.15
		504					

RESULTS / FINDINGS (Cont'd)

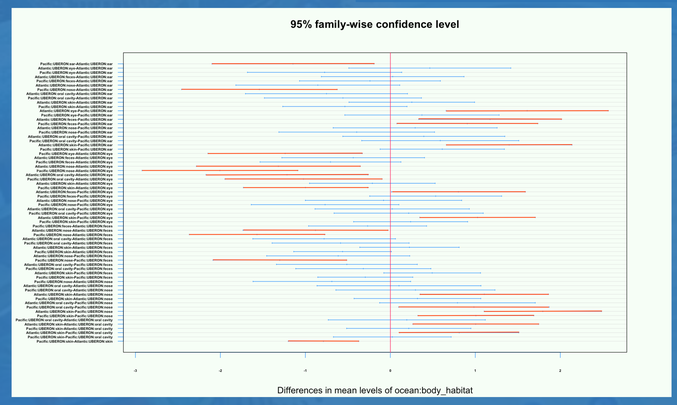
Analysis of Variance (ANOVA) & Tukey's Tests

P-Value

- Ocean 0.00000000000003946 *** (Statistically Significant)
- Body Habitat 0.00000000012034354 *** (Statistically Significant)

P-Value (Statistically Significant * between these specific groups only)**

- Pacific: nose - Atlantic: eye 0.00000 ***
- Pacific: nose – Atlantic: feces 0.00000 ***
- Atlantic: skin - Pacific: nose 0.00000 ***
- Atlantic: skin - Pacific: ear 0.00000 ***
- Pacific: skin - Atlantic: skin 0.00000 ***
- Atlantic: eye - Pacific: ear 0.00000 ***
- Pacific: nose – Atlantic: ear 0.00000 ***
- Pacific: nose - Pacific: feces 0.00001 ***
- Atlantic: skin - Pacific: eye 0.00006 ***
- Pacific: skin - Pacific: nose 0.00010 ***
- Atlantic: skin - Atlantic: nose 0.00012 ***
- Atlantic: feces – Pacific: ear 0.00035 ***
- Pacific: skin - Atlantic: eye 0.00055 ***
- Atlantic: nose - Atlantic: eye 0.00055 ***
- Pacific: eye - Atlantic: eye 0.00058 ***
- Atlantic: skin - Atlantic: oral 0.00062 ***
- Atlantic: oral - Atlantic: eye 0.00196 ***
- Pacific: ear - Atlantic: ear 0.00512 ***
- Atlantic: skin - Pacific: oral 0.00898 ***
- Pacific: oral - Pacific: nose 0.01533 ***
- Pacific: oral - Atlantic: eye 0.01612 ***
- Pacific: feces - Pacific: ear 0.01874 ***
- Atlantic: nose - Atlantic: feces 0.03531 ***
- Atlantic: feces - Pacific: eye 0.04201 ***



DISCUSSION / LIMITATIONS / FUTURE WORK

The preliminary findings and accompanying graphs demonstrate that Atlantic Ocean surfers have a higher Shannon index of microbial diversity than Pacific Ocean surfers in their bodies.

An analysis of variance (ANOVA) was conducted to test the hypothesis that there are significant differences in the mean Shannon index diversity across the Ocean and Body Habitat factors.

To further examine the differences among all groups, Tukey's Test (Post-Hoc Analysis) was conducted. The 95% confidence intervals and p-value showed that 24 out of 66 pairwise comparisons were statistically significant ***

One of the limitations of this study is the use of data that was collected more than five years ago. This may affect the relevance and validity of the findings, as the data may not reflect the current situation or trends. A future study could address this limitation by utilizing more recent data and also performing a comparative study of the surfing and non-surfing populations.

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REFERENCES

[1] The University of Newcastle Australia. Surfing bacteria reveal new insights into the ocean's health. Retrieved 03-21-2122 from https://www.newcastle.edu.au/newsroom/featured/surfing-bacteria-reveal-new-insights-into-the-oceans-health

Wickham et al., (2019). Welcome to the tidyverse. Journal of Open Source Software, 4(43), 1686, https://doi.org/10.21105/joss.01686